## AMENDMENTS TO THE SPECIFICATION

Please amend paragraph [0024], as follows:

[0024] Depending on the specific process, the substrate can be heated to some desired temperature prior to or during deposition. For example, the substrate support pedestal 48 may be heated using an embedded ~~heater~~ heating element 52A. The substrate support pedestal 48 may be resistively heated by applying an electric current from an AC power supply 52 to the ~~heater~~ heating element 52A. The substrate (not shown) is, in turn, heated by the pedestal 48. Alternatively, the substrate support pedestal 48 may be heated using radiant heaters such as, for example, lamps (not shown).

Please amend paragraph [0026], as follows:

[0026] A vacuum pump 18 ~~is~~ and the conduit system 46A are used to evacuate the process chamber 10 and to maintain the pressure inside the process chamber 10. A gas manifold 34, through which process gases are introduced into the process chamber 10, is located above the substrate support pedestal 48. The gas manifold 34 is connected to a gas panel (not shown), which controls and supplies various process gases to the process chamber 10.

Please amend paragraph [0028], as follows:

[0028] The gas manifold 34 includes a plurality of electronic control valves (not shown). The electronic control valves as used herein refer to any control valve capable of providing rapid and precise gas flow to the process chamber 10 with valve open and close cycles within a range from about 0.01 seconds to about 10 seconds, preferably from about 0.05 seconds to about 2 seconds and more preferably from about 0.1 seconds to about 1 second.

Please amend paragraph [0031], as follows:

[0031] Figure 2 is a schematic cross-sectional view of one embodiment of a chamber 80 including a gas delivery apparatus 130 adapted for cyclic deposition, such as atomic layer deposition or rapid chemical vapor deposition. A detailed description for a chamber 80 is described in commonly assigned U.S. ~~Patent Application~~ Publication No. 20030079686, and issued as U.S. Patent No. 6,916,398, and commonly assigned and co-pending U.S. ~~Patent Application~~ Serial No. 10/281,079, entitled "Gas Delivery Apparatus for Atomic Layer Deposition," [[,]] filed October 25, 2002, and published as US 20030121608, which are both incorporated herein ~~in their entirety~~ by reference in their entirety. The terms atomic layer deposition (ALD) and rapid chemical vapor deposition as used herein refer to the sequential introduction of reactants to deposit a thin layer over a substrate structure. The sequential introduction of reactants may be repeated to deposit a plurality of thin layers to form a conformal layer to a desired thickness. The chamber 80 may also be adapted for other deposition techniques.

Please amend paragraph [0036], as follows:

[0036] In one embodiment, the chambers depicted by Figures 1 and 2 permit the process gas and/or purge gas to enter the chamber 80 normal (*i.e.*, 90°) with respect to the plane of the substrate 90 via the gas delivery apparatus 130. Therefore, the surface of substrate 90 is symmetrically exposed to gases that allow uniform film formation on substrates. In another embodiment, the process gas may have a circular flow pattern, such as a "vortex," "helix," or "spiral" flow passing through the expanding channel 134 towards the substrate. The circular flow may establish a more efficient purge of the expanding channel 134 due to the sweeping action of the vortex flow pattern across the inner surface of the expanding channel 134 and a laminar flow efficiently purging the surface of the chamber lid 132 and the substrate 90. The process gas includes a ruthenium-containing precursor during one pulse and includes a reducing gas in another pulse.

Please amend paragraphs [0038] - [0039], as follows:

[0038] In one embodiment, the gas delivery apparatus 130 comprises a chamber lid 132. The chamber lid 132 includes an expanding channel 134 extending from a central portion of the chamber lid 132 and a bottom surface 160 extending from the expanding channel 134 to a peripheral portion of the chamber lid 132. The bottom surface 160 is sized and shaped to substantially cover a substrate 90 disposed on the substrate support 92. The expanding channel 134 has gas inlets 136A, 136B to provide gas flows from two similar pairs of valves 142A/152A, 142B/152B, which [[. The gas flows from the valves 142A, 142B]] may be provided together and/or separately.

[0039] In one configuration, valve 142A and valve 142B are coupled to separate reactant gas sources but are preferably coupled to the same purge gas source. For example, valve 142A is coupled to reactant gas source 138 and valve 142B is coupled to reactant gas source 139, and both valves 142A, 142B are coupled to purge gas source 140. Each valve 142A, 142B includes a delivery line 143A, 143B having a valve seat assembly 144A, 144B and each valves 152A, 152B includes a purge line 145A, 145B having a valve seat assembly 146A, 146B. The delivery line 143A, 143B is in communication with the reactant gas source 138, 139 and is in communication with the gas inlet 136A, 136B of the expanding channel 134. The valve seat assembly 144A, 144B of the delivery line 143A, 143B controls the flow of the reactant gas from the reactant gas source 138, 139 to the expanding channel 134. The purge line 145A, 145B is in communication with the purge gas source 140 and intersects the delivery lines 143A, 143B ~~142A, 142B~~ downstream of the valve seat assembly 144A, 144B of the ~~delivery line~~ valves 142A, 142B. The valve seat assembly 146A, 146B of the purge line 145A, 145B controls the flow of the purge gas from the purge gas source 140 to the delivery line 143A, 143B. If a carrier gas is used to deliver reactant gases from the reactant gas source 138, 139, preferably the same gas is used as a carrier gas and a purge gas (*i.e.,* an argon gas used as a carrier gas and a purge gas).

Please amend paragraphs [0041] – [0042], as follows:

[0041] Each valve 142A, 142B may be a zero dead volume valve to enable flushing of a reactant gas from the delivery line 143A, 143B when the valve seat assembly 144A, 144B of the valve is closed. For example, the purge line 145A, 145B may be positioned adjacent the valve seat assembly 144A, 144B of the delivery line 143A, 143B. When the valve seat assembly 144A, 144B is closed, the purge line 145A, 145B may provide a purge gas to flush the delivery line 143A, 143B. In the embodiment shown, the purge line 145A, 145B is positioned slightly spaced from the valve seat assembly 144A, 144B of the delivery line 143A, 143B so that a purge gas is not directly delivered into the valve seat assembly 144A, 144B when open. A zero dead volume valve as used herein is defined as a valve which has negligible dead volume (*i.e.,* not necessary zero dead volume). [[.)]]

[0042] Each valve pair 142A/152A, 142B/152B may be adapted to provide a combined gas flow and/or separate gas flows of the reactant gas 138, 139 and the purge gas 140. In reference to valve pair 142A/152A, one example of a combined gas flow of the reactant gas 138 and the purge gas 140 provided by valve 142A comprises a continuous flow of a purge gas from the purge gas source 140 through purge line 145A and pulses of a reactant gas from the reactant gas source 138 through delivery line 143A. The continuous flow of the purge gas may be provided by leaving diaphragm of the valve seat assembly 146A of the purge line 145A open. The pulses of the reactant gas from the reactant gas source 138 may be provided by opening and closing the diaphragm of the valve seat 144A of the delivery line 143A. In reference to valve pair 142A/152A, one example of separate gas flows of the reactant gas 138 and the purge gas 140 provided by valve 142A comprises pulses of a purge gas from the purge gas source 140 through purge line 145A and pulses of a reactant gas from the reactant gas source 138 through delivery line 143A. The pulses of the purge gas may be provided by opening and closing the diaphragm of the valve seat assembly 146A of the purge line 145A open. The pulses of the reactant gas from the reactant gas source 138 may be provided by opening and closing the diaphragm valve seat 144A of the delivery line 143A.

Please amend paragraph [0044], as follows:

[0044] In Figure 2, the expanding channel 134 comprises a channel which has an inner diameter which increases from an upper portion 137 of cap 172 to a lower portion 135 of the expanding channel 134 adjacent the bottom surface 160 of the chamber lid 132.

Please amend paragraph [0048], as follows:

[0048] Not wishing to be bound by theory, it is believed that the diameter of the expanding channel 134, which is gradually increasing from the upper portion 137 to the lower portion 135 of the expanding channel, allows less of an adiabatic expansion of a gas through the expanding channel 134 which helps to control the temperature of the gas. For instance, a sudden adiabatic expansion of a gas delivered through the gas inlet 136A, 136B into the expanding channel 134 may result in a drop in the temperature of the gas which may cause condensation of the gas and formation of particles. On the other hand, a gradually expanding channel 134 according to embodiments of the present invention is believed to provide less of an adiabatic expansion of a gas. Therefore, more heat may be transferred to or from the gas, and, thus, the temperature of the gas may be more easily controlled by controlling the surrounding temperature of the gas (*i.e.,* controlling the temperature of the chamber lid 132). The gradually expanding channel may comprise one or more tapered inner surfaces, such as a tapered straight surface, a concave surface, a convex surface, or combinations thereof or may comprise sections of one or more tapered inner surfaces (*i.e.,* a portion tapered, such as bottom surface 160 and a portion non-tapered, such as choke 162).

Please amend paragraph [0051], as follows:

[0051] The control unit 180 may be one of any form of general purpose computer processor that can be used in an industrial setting for controlling various chambers and sub-processors. The CPU 182 may use any suitable memory 186, such as random

access memory, read only memory, floppy disk drive, compact disc drive, hard disk, or any other form of digital storage, local or remote. Various support circuits may be coupled to the CPU 182 for supporting the chamber ~~100~~ 80. The control unit 180 may be coupled to another controller that is located adjacent individual chamber components, such as the programmable logic controllers 148A, 148B of the valves 142A, 142B. Bi-directional communications between the control unit 180 and various other components of the chamber 80 are handled through numerous signal cables collectively referred to as signal buses 188, some of which are illustrated in Figure 2. In addition to control of process gases and purge gases from gas sources 138, 139, 140 and from the programmable logic controllers 148A, 148B of the valves 142A, 142B, 152A, 152B the control unit 180 may be configured to be responsible for automated control of other activities used in wafer processing – such as wafer transport, temperature control, chamber evacuation, among other activities, some of which are described elsewhere herein.

Please amend paragraphs [0054] – [0055], as follows:

[0054] In one embodiment where a constant carrier gas flow is desired, a carrier gas stream is established within the process chamber as indicated in step 104. Carrier gases may be selected so as to also act as a purge gas for the removal of volatile reactants and/or by-products from the process chamber. Carrier or purge gases such as, for example, helium (He), argon (Ar), nitrogen ($N_2$), hydrogen ($H_2$) ~~and~~ or combinations thereof, among others may be used. The pulse of the purge gas lasts for a predetermined time interval, such as, within a range from about 0.01 seconds to about 10 seconds, preferably from about 0.07 seconds to about 2 seconds and more preferably from about 0.1 seconds to about 1 second. The carrier gas and purge gases may be provided at a flow rate between about 500 sccm to about 5,000 sccm, preferably between about 500 sccm to about 2,500 sccm for 200 mm substrates and between about 1,000 sccm to about 5,000 sccm for 300 mm substrates.

[0055] Referring to step 106, after the carrier gas stream is established within the

process chamber, a pulse of a noble metal-containing precursor is added to the carrier gas stream. The term pulse as used herein refers to a dose of material injected into the process chamber or into the carrier gas stream. The pulse of the noble metal-containing precursor lasts for a predetermined time interval, such as, within a range from about 0.01 seconds to about 10 seconds, preferably from about 0.05 seconds to about 1.5 seconds and more preferably from about 0.1 seconds to about 1 second.

Please amend paragraph [0058], as follows:

[0058] In step 108, after the excess noble metal-containing precursor has been flushed from the process chamber by the carrier gas stream, a pulse of a reducing gas is added to the carrier gas stream. The pulse of the reducing gas also lasts for a predetermined time interval. In general, the time interval for the pulse of the reducing gas should be long enough for adsorption of at least a monolayer of the reducing gas on the noble metal-containing precursor. The pulse of reducing gas lasts for a predetermined time interval, such as, within a range from about 0.01 seconds to about 10 seconds, preferably from about 0.1 seconds to about 2 seconds and more preferably from about 0.1 seconds to about 1 second. Thereafter, excess reducing gas is flushed from the process chamber by the carrier gas stream. Suitable reducing gases may include, for example, hydrogen (*e.g.,* $H_2$ or atomic-H), ammonia ($NH_3$), silane ($SiH_4$), disilane ($Si_2H_6$), trisilane ($Si_3H_8$), tetrasilane ($Si_4H_{10}$), dimethylsilane ($SiC_2H_8$), methyl silane ($SiCH_6$), ethylsilane ($SiC_2H_8$), chlorosilane ($ClSiH_3$), dichlorosilane ($Cl_2SiH_2$), hexachlorodisilane ($Si_2Cl_6$), borane, diborane, triborane, tetraborane, pentaborane, triethylborane ~~and~~ or combinations thereof, among others.